

(TCS-251411-65)
(16 December 1965)

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MEMORANDUM TO CHAIRMAN OF COMOR MC&G

SUBJECT: Research and Development Requirements for Satellite Image-
Forming Acquisition Systems for Mapping, Charting, and Geodesy

1. Enclosure 1, titled as above, provides the substantive body of information developed through the combined efforts of DIA and the Military Departments for the purpose of presenting the essential requirement statements and supporting information to COMOR and then to USIB for approval.

2. The additional R&D requirements for MC&G are recognized to be basically "geometric" in contrast to search and surveillance requirements that are concerned primarily with resolution and frequency of coverage. This basic difference in the nature of the requirement is principally the basis for proceeding on MC&G requirements at this time, recognizing however, the need for coordination with long-range requirements for other purposes as developed.

3. Paragraph 3, of the enclosure sets forth the specific requirements statements. Paragraphs 1 and 2 are considered supporting in that they describe the overall situation and present in broad terms the limitations of present systems. Since consideration of requirements normally raises the question of what can be done with today's systems against the requirements, paragraph 4 briefly describes the current evaluation of today's systems. Paragraphs 5 through 9 covering research objectives, overall system performance requirements, short term component developments, medium term developments, and long term applied research represent projections of the requirements statements in terms of specific aspects of research and development based on the experience of the mapping, charting and geodesy utilization community. These projections are not all intended to limit the state-of-the-art developments in the acquisition field, but merely to guide, in appropriate measure, such developments as related to actual use of the satellite research and data.

4. The information content of enclosure 1 may be greater than considered appropriate for forwarding to USIB for approval. After review of substantive information in enclosure 1 in the COMOR MC&G, it is recommended that the MC&G Working Group establish the scope of the requirements statements to be forwarded for USIB approval. On this basis, DIA would then

NRO review(s) completed.

prepare an abbreviated version, as needed, and then both the abbreviated version and enclosure 1, appropriately modified with any substantive changes for use as a back-up paper, could be reviewed finally in the COMOR MC&G, and then forwarded to the COMOR for approval. Actions, incident to obtaining USIB approval, would then be planned.

5. All of the requirements statements included in paragraph 3 are subject to revision due to changes in weapons systems capabilities, tactics of warfare and the continual DoD evaluation of what accuracies are justified in MC&G products. The two most critical accuracy requirements, that is, contour accuracies over a specific effective distance and world-wide position and elevation requirements, are not expected to change greatly in the immediate future. On the other hand, the accuracies indicated for a photogrammetric control net are quite tentative, particularly with respect to vertical control. Further intensive validation actions are under way to establish a more complete justification for an appropriate accuracy requirement in the next 2 to 3 months. This refinement action is not considered a matter that should delay action in any way on the overall MC&G requirements statements.

6. In support of the requirements set forth in enclosure 1, the Department of Defense will maintain a continual evaluation of accuracy requirements related to essential military needs, areas of the world for which satellite data are needed and the capabilities of satellite acquisition and utilization systems, both existing and under development, as the basis for establishing priorities for the research and development of acquisition systems.

7. In planning for discussion of this matter in the COMOR MC&G Working Group, it is recommended that substantially the explanatory information in this memorandum be disseminated with the enclosure to this memorandum to COMOR MC&G addressees. Further, it is recommended that a COMOR MC&G Working Group meeting to discuss this matter be scheduled not earlier than 27 December, but the actual date be determined after distribution of this material.

signed

[redacted]
DIA COMOR MC&G Member

1 Enclosure a/s
cc: DIA COMOR Member [redacted]

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Enclosure 1

(TCS-251068-65)

1. Introduction

The purpose of this document is to define the research and development required for image-forming satellite acquisition systems in order to satisfy present and future mapping, charting, and geodesy requirements. Research and development effort should be directed towards the perfection of advanced instruments and techniques to acquire cartographic data with increased speed, accuracy, and economy. The speed and accuracy requirements are prompted by the Sino-Soviet threat to the U.S. and the planned global mobility of U. S. general purpose forces. These fundamental situations emphasize the peacetime need for world-wide mapping, charting, and geodetic information collection for accurate map and chart production.

To meet these needs it is essential that technological advances be exploited as they appear and that the experience of the mapping, charting, and geodetic community be utilized to guide future developments aimed at meeting current and foreseeable requirements. The process of meeting these objectives involves comparing various systems capabilities (either demonstrated or anticipated) with critical established requirements and arriving at a determination of the direction in which future developmental effort should be directed. A major

consideration in defining the research and development needs is that the systems and systems components have a high degree of assurance of meeting present and foreseeable cartographic requirements.

2. Deficiencies of Present Acquisition Systems

a. The original KH-4 system was recognized immediately by the MC&G community as having definite potential for preparing maps and charts. Methods, techniques, and equipment were developed to use these materials for compiling small, medium, and large scale maps. It was demonstrated that KH-4 materials could be employed to compile small scale maps very effectively; while it could meet nearly all detail requirements, it could only approach the accuracy requirements for Series 200 Aeronautical Target Charts (ATC), marginally meet the accuracy requirements for medium scale topographic maps and cannot meet accuracy requirements for large scale maps. The difficulty stems mainly from the lack of precise geometry of the Panoramic Camera System and insufficient attitude determination of the frame camera. While the present KH-4 system shows potential capability for meeting world mapping requirements, it suffers from several deficiencies:

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3. Requirements

The requirements to be considered as a basis for satellite acquisition system research and development needs refer only to those critical mapping, charting, and geodesy requirements updated by current validation actions as set forth in successive paragraphs.

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d. Interpretation Requirements

Satellite photography should permit interpretation of those features normally required to be shown on maps and charts. These features are detailed in mapping and charting specifications,

and available studies. Generally, the required interpretation capability is reached by a resolution of 10 feet on the ground, including round and square objects, for those features represented by 2-1 contrast level on the film, developed to a density of .3 minimum to 1.6 maximum.

e. Coverage Requirements

Because of the Sino-Soviet threat to the U. S. and the requirement for a high degree of mobility for our own general purpose forces, the need exists for collection of mapping-charting data over extensive areas world-wide for medium and small scale maps and charts. Specific areas comprising approximately 10,000,000 square miles require photographic coverage for meeting current large scale topographic mapping requirements. While world-wide coverage of present KH-4 data is justified as a data bank because of its extreme value for up-to-date cartographic detail, in relative horizontal positioning and improvements in contour capability, [REDACTED]

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f. Other Considerations

In addition to those requirements above, it is presumed the state-of-the-art in airborne and ground weapon systems will

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Enclosure 1

continue to advance. There is a resulting requirement for continuous review of the state-of-the-art of acquisition systems, for possible modification of utilization equipment and exploitation to obtain more accurate maps and charts, produced more efficiently and rapidly than at present. Periodic review of all research and development programs by both acquisition and utilization personnel is needed.

4. System Capabilities vs. MC&G Requirements

a. General

The amount by which existing and near future satellite photographic acquisition systems meet (or fail to meet) the established mapping, charting, and geodesy requirements determines the degree of future research and development needed and indicates to some extent the type of system required. The use of actual test results is the best criterion to measure system capability, but is of limited value in this case since tests have only been performed on existing systems (KH-4, KH-5⁷). Estimates of the capabilities of near term improvements [redacted]

[redacted] to the KH-4 system by cognizant agencies are varied in the case of the reseau because of uncertainty as to the improvement in accuracies which will result.

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b. Maps and Charts

Test compilations made from the KH-4 system photography showed the maximum accuracy of contours (90% assurance) attainable within one map sheet area measured on a relative basis to be approximately 50-70 meters for medium scale and 10-40 meters for large scale products. These tests and experiences to date indicate that the present KH-4 system, under the optimum conditions of 100 nautical mile altitude and using advances equipment such as the AP-2 or can provide contours with an accuracy of 100-160 feet (30-50 meters) over the effective distance of 20-30 miles related to the critical medium scale requirement. Similarly, for large scale maps present systems can provide contours to an accuracy of 35-130 feet (10-40 meters) over the effective distance of 10-20 miles. Present systems meet the relative horizontal position requirement at medium scale, but do not meet other mapping or charting accuracy requirements set forth in paragraph 3.a. and 3.b. above. Under certain conditions and using special procedures, the accuracies stated in this paragraph can be improved further; however, these figures should be considered representative of

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standard practice.

Estimates on the accuracies obtainable from the
near term improved KH-4 system vary considerably.

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c. Point Positioning

Tests performed on KH-5 (DAFF) photographic data indicate that the horizontal accuracy of point position determination obtainable by 1968 on a world-wide basis is approximately 750 ft. (90% circular assurance) based on presently available geodetic surveys. It is further estimated that with the incorporation of improved data to be obtained by overt geodetic satellite systems and other satellite photo systems, the utilization of advanced horizontal data reduction programs, the development of an improved gravity model and satisfactory coverage throughout the world, it is believed that the horizontal positioning accuracy requirement of 450 ft. (90% assurance) can be achieved by 1970. Even with

these improvements, present and near-term improved systems using orbital data techniques range from doubtful to marginally capable of meeting the 300 ft. vertical data requirements. Similarly, limitations in the horizontal and pointing accuracy cause both present and near-term improvement systems to be inadequate in meeting the world-wide 175 ft. vertical data objective. With respect to providing a relative photogrammetric control framework for coordinated series production of maps and charts, existing systems provide data ranging from adequate for small scale maps and charts to inadequate for large scale maps; networks for medium scale maps are marginally adequate varying with the extent of collateral geodetic data.

d. Information Content

Analysis of the KH-4 system panoramic photography at 100-150 nautical miles reveals that the information content requirements, in terms of ground resolution obtainable for medium and large scale maps and charts, are presently being satisfied. Generally, medium and small scale maps require less stringent detail interpretation capability such that most of the cartographic features are interpretable from photography having a resolution of 25-30 ft. on the ground, which could be obtained by present KH-4 systems operated at the altitude of 200-300 nautical miles.



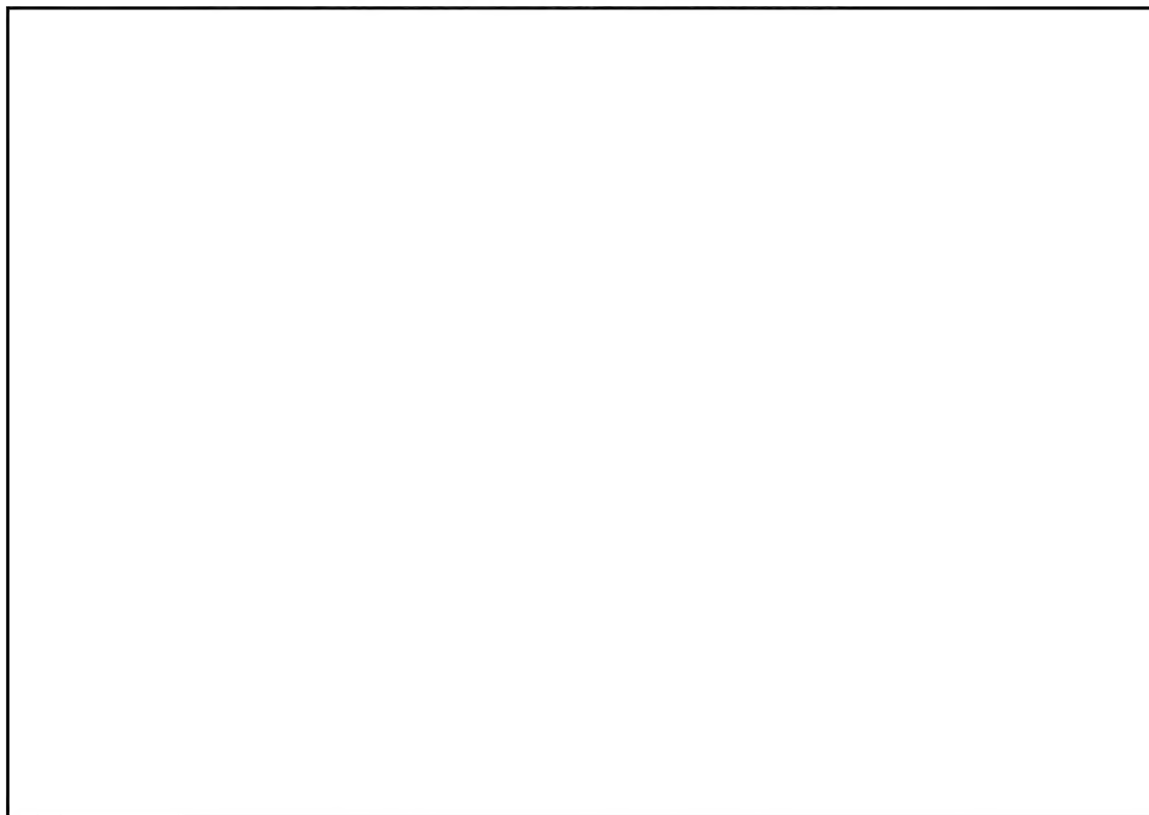
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5. Research Objectives

In view of the above discussion, it is necessary that future R&D development of satellite mapping systems be guided towards meeting the following objectives:

a. Achieve accuracy requirements.

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e. Provide increased cost effectiveness based on system design, reduction of data, and exploitation of reduced data in weapon system performance.

The present KH-4 system with near term improvements

and in conjunction with geodetic programs should meet at least marginally on a production basis objective 5.a., with respect to medium scale maps-charts based on present and foreseeable weapon system requirements,

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The requirements for research and development on photographic satellite acquisition systems for mapping, charting, and geodesy discussed below are based on improving system capabilities such that the objectives stated above can be satisfied. In addition, consideration is given for improving acquisition system capabilities towards meeting more stringent demands which may occur in the future or may permit a trade-off, allowing economies to be realized or a justified improvement in the product or service provided. The requirements for improving systems capabilities are placed into three time intervals considered to be logical and practical separation points for phasing research and development activities.

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